

Title: Influence of Sea Surface Temperature on the Columnar Water Vapor Content and Cloud Fraction, Based on Monthly-Averaged MODIS Data at 1° by 1° Resolution

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Recommendation

Decline

General comments

In this study, the authors investigate the relationships among sea surface temperature (SST), column water vapor (CWV), and cloud fraction (CF) using monthly averaged $1^\circ \times 1^\circ$ MODIS observations. They find a universal relationship between SST and CWV, as well as between SST and CF. In both relationships, the dependence on SST changes around 300 K.

The motivation for this study is understandable, as it addresses a classic problem in atmospheric science, and it is well known that both CWV and CF are primarily dependent on SST. However, it is also well known that they are not solely determined by SST. For example, Kanamaru and Masunaga (2013) introduced the water vapor scale height and found that the relationship between CWV and SST varies systematically with this parameter. Such studies have shown that the dependence of CWV or CF can be further refined by considering additional key parameters in addition to SST.

It is not clear why the authors chose to use the MODIS dataset. CWV is not directly retrieved from MODIS observations, and SST retrieval from MODIS is inherently limited in cloudy regions. Several more reliable and widely used datasets are available for both CWV and SST.

For the above reasons, I find that the present analysis is too simplistic to provide a comprehensive understanding of how CWV or CF is determined. A more thorough investigation should incorporate multiple observational datasets and consider additional controlling factors beyond SST.

Therefore, I do not recommend publication of the manuscript in its present form. The authors should substantially reconsider the approach; employing more appropriate datasets and more comprehensive analyses would be required

Specific comments

L47-48, "The atmospheric optical depth and cloud fraction are close correlated (Engstrom and Ekman, 2010; Gryspeerd et. al, 2014).": These literatures focus on the aerosol optical

depth. It is not relevant to the present study.

L60-62, “Waliser (1996) investigated the SST-atmosphere interaction by examining thermodynamic and convection dynamic variables, suggesting that there is a feedback mechanism to suppress locally high SST.: “Waliser (1990)” is not listed in the reference. The feedback mechanism is not relevant to the present context.

L66, “vertical gradients”: It is unclear what quantity the authors are referring to. Please specify the variable whose vertical gradient is being discussed.

L79-80, “However, detailed and accurate simulations of entire global circulation are intrinsically difficult and time-consuming”: This statement is no longer appropriate, as detailed and accurate representations of the global atmospheric circulation are now readily available from high-resolution reanalysis datasets, such as ERA5.

L106-108, “Detailed descriptions of the data and processing methods are discussed by various authors of the MODIS data set (<https://modis.gsfc.nasa.gov/data/>).”: The authors should review scientific papers on the MODIS data set and find their limitations and the rationale for using it in the present analysis.

L120, Figure 1: Which domain on the Earth is analyzed here? The CWV-SST relationship should be analyzed separately in the tropics and extratropics.

L121, “a Clausius-Claperyon (CC) form of exponential dependence on SST is observed up to SST of approximately 300 K.”: To discuss deviations from the Clausius–Clapeyron (CC) relationship, the authors should explicitly compare the observed relationship with that predicted by the CC relationship. For example, they could produce a scatter plot of the theoretical CC scaling against the observational results to quantitatively assess deviations.

L131-133, “During some months, the data are bifurcated for SST < 285 K, with upper branch exhibiting higher WV than the lower CC branch. These months are also associated with larger scatter in the data, in Figure 1.”: The authors should demonstrate this evidence.

L143-145, “Data plotted in Figure 1 indicate that the water vapor content is “over-saturated”, higher than the water vapor pressure at the corresponding SST, SST of approximately 300 K.”: It is unclear from Figure 1 how the authors reached the conclusions

described in the text. The authors should provide additional analyses and supporting figures that directly demonstrate these findings.

L160-163, “The physical mechanism for this reversal and increase in CF above the threshold temperature (T_c) may again be attributed to the increased upward convection at high SST, distributing the water vapor to higher altitude resulting in more vapor available for condensation and cloud formation.”: The reversal in the CF relationship is one of the most interesting findings of the present study and deserves a more in-depth investigation. The authors should explore the underlying physical mechanism by analyzing additional meteorological fields (e.g., reanalysis data), such as convection, large-scale circulation, and humidity.